Needle-Free Injections

For the millions of Americans afraid of needles, help may be on the way. A new medical device now available in some hospitals and clinics can inject medicines without the jab of a needle. The device, called SonoPrep®, is initially being used to numb skin for painful procedures such as the insertion of catheters or intravenous tubing.

SONTRA MEDICAL CORPORATION

Traditionally, doctors numb skin before doing these procedures by injecting a local anesthetic medicine through a needle. This method can take up to an hour and it hurts, whereas SonoPrep does the job painlessly in just 5 minutes.

SonoPrep works through ultrasound technology. Developed with NIGMS funding by **Robert Langer** of the Massachusetts Institute of Technology in Cambridge, the device uses battery power to apply low-frequency sound waves to skin for 15 seconds. This ultrasonic energy subtly rearranges the distribution of fat molecules, creating tiny canals in the skin.

Small quantities of liquid can flow into and out of these channels, enabling the painless delivery of anesthetics or other medicines. The skin isn't harmed by the process, and within a day it returns to normal.

Langer, a chemical engineer and the inventor of many novel methods to deliver medicines, has much more in mind for SonoPrep. He licensed the technology to a company, Sontra Medical Corporation in Franklin, Massachusetts, that plans to test the needle-free injection system for various other medical uses, including vaccination.

Plans are also under way to test SonoPrep's ability to measure blood sugar in people with diabetes and give just the right amount of insulin when needed. —*Alison Davis*

Finding a Single Microbe

Outbreaks of the potentially deadly bacterium *E. coli* O157:H7 pose a serious health risk. As few as 10 to 100 of these microbes in contaminated food or water can kill people who are especially vulnerable to infection, such as young children and the elderly.

Unfortunately, finding such miniscule amounts of bacteria in food or body fluids is very difficult and time-consuming. Standard techniques require a lot of sample material and can give false results. Better methods for the quick and accurate detection of bacteria are urgently needed for protecting public health.

To make progress on this front, NIGMS grantee **Weihong Tan** of the University of Florida in Gainesville used nanotechnology. A key goal of this new area of science is to learn how to build structures and devices at the nanometer scale. (There are 25 million nanometers in 1 inch.)

The chemist designed a tiny, nanometer-sized biosensor to detect *E. coli* O157:H7 by attaching an antibody, a protein that can grab tightly onto the microbe, to a "nanoball." When it detects as little as a single bacterium, the nanoball-antibody combination glows brightly. This is because the microscopic nanoball biosensor is packed with thousands of dye molecules that give off a fluorescent signal on contact with the microbe.

To test the practicality of this approach, Tan spiked samples of ground beef with very small amounts of *E. coli* O157:H7, then mixed the spiked and unspiked samples with nanoball biosensors. The technique worked: only the contaminated samples lit up.

While the approach will require scaling up for more widespread use, Tan believes it will speed the development of rapid and highly sensitive new tools for disease surveillance and diagnosis. —*A.D.*

Seeing Red

Hair color, like many other aspects of our appearance, is inherited. But genetic factors also influence less visible characteristics, such as how we respond to medicines.

Anesthesiologists have long observed that people with naturally red hair may need more anesthesia and have wondered if heredity plays a role. NIGMS grantee **Daniel Sessler** of the University of Louisville School of Medicine in Kentucky decided it was time to put the issue to the test.

Sessler, an anesthesiologist, recruited 10 women with naturally bright red hair and an equal number with black or dark brown hair. He gave the women a commonly used inhaled anesthetic, then applied a small electric shock to each woman's thigh and watched for a reflex movement, an indication that the anesthetic dose was too low. The women did not feel or remember the shock.

Sessler adjusted each woman's dose until she had a reflex movement only half the time, a standard method for determining the appropriate individual dose of an anesthetic medicine. He found that nearly all of the red-haired women needed 20 percent more anesthetic than did those with dark hair.

Just about all people with red hair share a common genetic variation that affects hair and skin color. After analyzing DNA from the women in the study, Sessler identified this genetic variation in 90 percent of the red-haired women who needed more anesthesia. In a separate study, he discovered that redheads also get less pain relief from local anesthesia, the kind you often get at the dentist.

While the study findings do not directly link hair color genes to anesthesia response, they do suggest that health care providers should monitor anesthesia doses carefully in redheads. More broadly, the research opens the door for further study of the role of heredity in anesthesia response.—*A.D.*

Bone Marrow Powers Wound Healing

The body automatically springs into action to heal a wound. It does this by grouping together certain cells in the bloodstream so they can form a clot and short-circuit a potential infection.

Researchers have long known that the infection-fighting cells come from bone marrow, the spongy material inside bones. But recently, scientists discovered that the bone marrow-derived cells also play a role in healing wounds and keeping skin healthy.

NIGMS grantee **Frank Isik** of the University of Washington Medical Center in Seattle made the discovery using experimental mice whose bone marrow cells were engineered to glow green under a fluorescent light. He took the glowing bone marrow cells from these mice and put them into another set of mice that were genetically the same but hadn't gotten the cells that could glow.

Isik, a plastic surgeon-researcher, then made a small incision in the back skin of the transplanted mice. To his surprise, as long as 6 weeks after the mice had been wounded, and well after they were no longer at risk for infection, the luminescent cells derived from the bone marrow remained in their healed skin.

Isik also discovered that only the bone marrow-derived cells were able to make a particular type of collagen found not just in healed wounds, but in skin all over the body. This led him to conclude that cells from bone marrow help form the tough, yet expandable, matrix of skin.

Isik now wonders whether diseases that interfere with wound healing, such as diabetes, do so because they affect bone marrow cells. In time, this line of research may reveal targets for drugs to speed wound healing.—*A.D.*

Wild Ox vs. Mosquito

Warm, summer evenings by the lake can be so peaceful and relaxing…except for the torrent of mosquitoes that seems to attack every uncovered inch of your skin. In some places in the world, the outcome is worse than simple itching.

Mosquitoes in the steamy rainforests and jungles of Southeast Asia and India transmit life-threatening diseases that include yellow fever. Although an effective vaccine for this infectious disease has been available for more than 60 years, the number of people infected has been rising. For this reason, yellow fever has re-emerged as a serious public health threat.

Fortunately, nature provides some protection for the wildlife living in these muggy climates. For example, large beasts such as oxen (also known as gaurs) that inhabit these tropical areas ooze a natural skin secretion called gaur acid. Scientists think that this chemical protects gaurs by discouraging the landing and feeding of *Aedes aegypti*, one type of mosquito that carries and transmits the yellow fever virus.

In the future, people may benefit from this treasure in nature's medicine chest. NIGMS grantee **P. Andrew Evans** of Indiana University in Bloomington recently learned how to make gaur acid in his lab.

It was no easy feat, considering that before the chemist began working on the problem nobody knew how gaur acid's molecular pieces snap together. Using a helper molecule called a rhodium catalyst, Evans produced gaur acid in just seven chemical steps.

He anticipates that the method could be industrialized fairly easily to make large quantities of this natural insect repellant.—*A.D.*

These stories describe NIGMS-funded medical research projects. Although only the lead researchers are named, science is a team sport and it is important to realize that many researchers work together to carry out these studies.